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DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

QUARTZ AND SILICA

PART III. - SAND AND MISCELLANEOUS SILICAS

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R. M. SANTMYERS

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QUARTZ AND SILICA[1]

PART III. SAND AND MISCELLANEOUS SILICAS

By R. M. Santmyers[2]

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FOREWORD

Of the sand and miscellaneous silica produced in the United States, ordinary sand and gravel are, of course, the most important, at least as regards volume of output. The building-construction industry absorbs approximately 75 per cent of the total value of all quartz and silica, as shown in Table 2 of Quartz and Silica, Part I, under "General summary."

Because of their unusual physical properties tripoli and diatomite find extremely wide uses in industry, and as the commercial deposits of these minerals, especially tripoli, are scattered, large quantities enter into interstate commerce. Whereas ordinary sand and gravel are bulky commodities, these specialties have a fairly high unit value and hence can be transported relatively long distances.

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[1] The Bureau of Mines will welcome reprinting of this article, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6474."

[2] Mineral specialist, Rare Metals and Nonmetals Division, U. S. Bureau of Mines.

FUSED-SILICA GLASS

Fused-silica glass made from opaque crystal quartz or very high-grade silica glass sand is used to a considerable extent in the chemical industry.

For laboratory equipment and chemical ware fused silica and quartz apparatus frequently can replace platinum and other expensive materials. The remarkably low coefficient of expansion of fused-silica products enables them to withstand rapid changes in temperatures which are impossible for glass, porcelain, and other ceramic materials. The melting point of fused silica is about 1700° C. or approximately the same as they of platinum. However, a softening of the material will take place at 1500° C. Fused-silica products will therefore withstand temperatures of 1500° C. or 2642° F. for short periods or permanently if the temperature is not lowered. They will withstand temperatures of 1150° C. or 2102° F. permanently under all conditions.

Acids in general, whether mineral or organic, have little or no effect upon fused silica. Exceptions are hydrofluoric and, at high temperatures, phosphoric acid. Mixtures of acids, such as aqua regia, which readily attacks platinum, will not affect fused quartz. Although caustic soda and other alkalies will slightly attack the surface, fused silica frequently may be used even with these chemicals with satisfactory results. Certain metals, however, in particular alkali metals, will form a flux with silica at high temperatures, and for chemicals of this nature and under these conditions fused silica ware can not be used.

SODIUM SILICATE

Sodium silicate, or as it is more commonly known, "water glass," is a chemical combination of silica (SiO_2) and soda (Na_2O) formed by dissolving crushed quartz in hot caustic soda under pressure or by calcining a mixture of quartz sand, an alkaline soda salt such as soda ash, and charcoal. The resultant product is a colorless, transparent, glasslike mass which dissolves more or less easily in boiling water to form a thick liquid.

Quartz is used to a limited extent in the manufacture of sodium silicate, but sand of satisfactory purity is readily available, is cheaper than crushed quartz, and therefore is the raw material usually employed, although diatomite is also used, notably in California. High-grade silica sand, especially low in iron and alumina, is used for the manufacture of sodium silicate, as alumina makes the resulting silicate difficultly soluble, and iron salts affect the color.

The general requirements are that the sand must contain at least 99 per cent silica, with not over 1 per cent alumina, not over 0.5 per cent lime and magnesia combined, and less than 0.1 per cent iron. It is desirable that the sand should all pass 20-mesh and remain on 100-mesh, which is approximately the same as requirements for sizing a high-grade glass sand. In fact, a good glass sand is usually considered suitable if low enough in alumina.

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Sodium silicate is placed on the market in several forms, as a solution, in lump form, and as powder; each has its specific uses.

In a bulletin (No. 17-R entitled "Silicates of Soda, Grades and Uses,") issued by the Philadelphia Quartz Co. the uses of sodium silicate are classified under five major headings, as follows:

Classification of Uses

Silicate Cements

- Acidproof cements
- Abrasive wheels
- Furnace cements
- Stove cements
- Digestor linings
- Sagger cements
- Frit making
- Hardening concrete
- Dustproofing concrete
- Curing concrete roads

Adhesives

- Corrugated-paper board
- Combined fiber board
- Wall board
- Sealing shipping containers
- Asbestos aircell
- Plywood
- Paper tubes
- Parquetry flooring
- Fiber trunks
- China cements

Sizes and Coatings

- Greaseproofing paper
- Testing and sizing barrels
- Fireproofing wood and curtains
- Sizing fertilizer bags
- Silicate paints
- Stainproofing lumber
- Paper sizing
- Silk weighting

Deflocculation and Detergency

- Deflocculating clays
- Ore flotation
- Oil refining
- Crankcase oil reclaiming
- Soap
- Peroxide bleaching
- Hypochlorite bleach
- Boiling of cotton goods

Gelatinous Films and Gels

- Cleaning aluminum
- Rust prevention
- Egg preserving
- Gel manufacture

SILICON CARBIDE

Trade names for silicon carbide (SiC) include carborundum, carbosil, carbolon, crystolon and others. These products are made in the electric furnace by heating a mixture of coke, sand, salt, and sawdust. Crushed quartz may be used; but silica sand is usually employed, as it is cheaper and more readily available.

Good-quality glass sand is usually satisfactory for silicon carbide. Manufacturers require a sand that contains 99 to 99.5 per cent silica and is low in iron, as this impurity is particularly objectionable. More than a trace of lime, phosphorus, and magnesia should not be present, but alumina in small amounts is not considered particularly harmful. All grains should pass a 20-mesh sieve and contain no material smaller than 150-mesh.

Silicon carbide is characterized by extreme hardness, and its principal use is for abrasive purposes. Since it is infusible and only oxidizable at extremely high temperatures it is admirably adapted for refractories. Finely powdered carborundum may also be made into a highly refractory paste with fire clay, lime, and sodium silicate and applied to bricks intended for use in smelting furnaces. It is stated that a coating one-twelfth of an inch thick will protect the bricks from the attack of extremely high temperatures.

Table 1 which follows, shows the sales of silicon carbide in the United States from 1920 to 1929, inclusive.

Table 1. - Sales of silicon carbide in the United States[1]

	Short tons	Value	Average value per ton
1920	6,887	$ 1,309,605	$ 190.15
1921	2,707	475,336	175.60
1922	16,233	2,022,613	124.60
1923	21,149	2,786,929	131.78
1924	17,792	2,161,498	121.49
1925	24,112	2,493,756	103.42
1926	17,026	1,702,037	99.97
1927	26,289	2,603,571	99.03
1928	22,162	2,286,518	103.17
1929	30,309	3,060,401	100.97

1/ Bowles, Oliver, Abrasive Materials: Mineral Resources of the U. S., Part II, Nonmetals, Bureau of Mines, 1930, p. 81

CONSTRUCTION INDUSTRY

Enormous quantities of silica in several forms are used in the construction industry. Sand and gravel, of course, are the most important as regards both tonnage produced and total value. Sandstone and quartzite, in quarried form are also used to a great extent; the former in fact represents by far the larger part of the dimension stone so used.

The most common form of silica, structural sand, includes those varieties used in all forms of concrete, mortars, and plasters. Although each kind of structural sand has different requirements as to size of minimum and maximum grain, amount of fines and allowable impurities, certain general characteristics are common to all grades. Virtually all specifications require the sand to be clean and reasonably free from clay-coated grains, lumps of clay, flat or elongated grains, vegetable or organic matter, and pyrite.

The Sand and Gravel Association and the United States Bureau of

Standards, in collaboration with the American Society for Testing Materials, have promulgated certain tentative specifications as regards sand and gravel for the construction industry. These are touched upon in general in Bureau of Mines Bulletin 266, Technology and Uses of Silica and Sand, by William W. Weigel; further information may be obtained from the above organizations.

Structural sand may be divided into two major classifications, building sands and paving sand. Building sands in turn may be further divided into sand for concrete other than paving, brick-mortar sand, and plastering sand. Paving sand is divided into four general classes, according to uses--sand for concrete pavements, sand for asphaltic or bituminous pavements, sand for grouting, and sand for bedding or cushioning.

Building Sand

Concrete sand.--Concrete sand or fine aggregate is the sand used for general concrete work other than pavements and accounts for the largest part used under this heading. The sand must be clean and have hard, strong, durable, uncoated grains free from injurious amounts of clay, silt, and vegetable and organic matter. All the sand must pass a 3/8-inch sieve, 85 per cent a No. 4 sieve, and not more than 30 per cent a No. 50 sieve.

Brick-mortar sand.--Sand for this purpose should have the same general characteristics as that for concrete, except that in facework, where thin joints are used, the sand should all pass a 1/4-inch sieve, as that is the usual thickness of facework brick joints. Color is important for facework if white joints are desired. For other work, or where mortar color is used, the color of the sand is immaterial.

Plastering sand.--Sand for plastering may be used with lime plaster, gypsum plaster, or a mixture of both. Sand used for plaster in which gypsum is employed should consist of fine granular material containing not less than 80 per cent by weight of silica, feldspar, dolomite, magnesite, or calcite and should be free from organic and vegetable matter. It should be graded evenly from fine to coarse, and when dry not less than 80 per cent should remain on a No. 50 sieve. Sands graded so that less than 80 per cent remains on a No. 50 sieve have proved to be nearly as satisfactory when used with lime or gypsum but showed less tensile strength in cement mortar.

Paving Sand

Sand for concrete pavements.--This sand is of one grade, although formerly a different grade was sometimes specified for the wearing surface than for the base if the pavement was laid down in two courses. Preference should be given sand composed of a mixture of coarse and fine grains, with the coarse grains predominating. Sand with even small mounts of organic impurities is unsuitable, especially when used for the wearing surface. It is recommended that 100 per cent pass a 1/4-inch screen and that 50 to 90 per cent pass a No. 10 sieve and be retained on a No. 50 sieve.

Sand for asphaltic pavements.--Such sand includes for sheet-asphalt binder and wearing courses and for bituminous concrete base and wearing courses.

The general requirement for these sands is that they shall be composed of clean, hard, durable grains free from a coating of clay or loam. The presence of small amounts of organic matter is not objectionable, as in sand for concrete. All the sand should pass a 1/4-inch screen, 95 to 100 per cent a No. 10 sieve, and not more than 5 per cent a No. 200 sieve. For binder courses it is usually specified that the sand shall all pass a 1/4-inch screen and not less than 94 per cent be retained on a 200-mesh sieve.

Grouting sand.--This sand is used for making a thin cement mortar with which the joints between paving blocks or bricks are filled. The sand should comply with the same general requirements as to freedom from impurities that govern other mortars. As the grouting must flow into thin joints the size of the maximum grains permissible is reduced. All the sand should pass a 10-mesh sieve, and not less than 80 per cent should pass a 20-mesh sieve.

Bedding sand.--Sand for the sand bed or cushion on which paving blocks or bricks are laid should be reasonably clean and free from foreign substances, although this requirement need not be as strict as for sand entering into mortar of any kind. It is usually specified that all should pass a 1/4-inch screen, at least 90 per cent pass a No. 10 sieve, and not more than 5 per cent be removed by elutriation. It should be well graded from coarse to fine.

Sand-Lime Brick

Sand in sand-lime brick has a twofold function. Most of it acts simply as an aggregate making up the body of the brick, which is bound together by the cementing material. The remainder supplies silica for the formation of the monocalcium silicate bond. For this second function a certain amount of very fine material must be present, as the action of lime on the largest grains under manufacturing conditions of temperature and pressure is quite slow. According to the Bureau of Standards at least 15 per cent of the sand present should pass a 100-mesh sieve, as this fine material is acted upon by the lime in the least possible time. The remainder should be well graded from coarse to fine, although oversize grains are objectionable, as it is impossible to mold brick having sharp corners and edges with them.

Extreme chemical purity is not essential, but the sand should be reasonably clean and free from organic substances. The sand should be sharp, as this is usually considered better, but there is no reason why rounded-grain sand will not make a satisfactory brick if enough fines are present.

MOLDING SAND

Molding sand may be separated into two general classes--that with and that without natural bond. Sand of the first class, when removed from the bank, contains sufficient clay, loam, or other foreign material to bond it enough when tamped into place around the pattern. Sand of the second class does not contain sufficient natural bonding material, and some such substance as refractory clay organic binder must be mixed with it. Sand with little or no natural bond is often termed silica sand or steel molding sand, as it is generally high in silica and more refractory than the natural bonded sands; in consequence, it is used for steel molding where high refractoriness is necessary.

Naturally bonded sand is sometimes called "foundry sand," "iron-molding sand," or simply "molding sand" as differentiated from "silica sand." In general, it is used for molding cast iron and the nonferrous metals or alloys, such as brass.

The general properties or characteristics that determine the value of a sand for foundry purposes are: (1) Bond or cohesiveness; (2) permeability; (3) grain size; (4) refractoriness; and (5) durability.

The bond or cohesiveness is probably the most important property required of a molding sand, as it is the bond that allows the sand to be molded intricately without falling in of its own weight. The material of the bond is usually considered as clay and generally takes the form of a mixture of hydrated iron oxide and hydrated aluminum silicate.

Permeability, the property of permitting the flow of gases through the mold, is very important in a sand, as it allows gases to escape from the hot metal without causing "blows" in the casting. Angular, coarse sand has higher permeability than round-grained fine sand. The grains of sand are of fairly uniform size and are not graded from fine to coarse.

The size of grain is important, as it affects permeability and determines the use of the sand. Very coarse material is used for the heaviest work and fine-grained sands for light work and for smooth castings. The coarse sand may be a product all of which will just pass a 3-mesh sieve with about 50 per cent retained on 20-mesh. A sand of which 74 per cent or more will pass a 200-mesh sieve is considered fine grained.

The refractoriness of a molding sand depends largely upon its chemical and mineralogical composition. In general, sands high in silica are the most refractory, and those in which the percentage of alkalies is high are least refractory. Sands for steel molding usually contain more than 96 per cent of silica before addition of the artificial bond, which may be fire clay. Some naturally bonded sands, however, may contain as low as 57 per cent of silica.

Most naturally bonded sands, however, contain 75 to 90 per cent of total free and combined silica.

The durability of a sand fixes the number of times it can be used and to a large extent the amount of new sand that must be added to a mold, although the latter will seldom be made up entirely of used sand. Lack of durability is due to loss of bond by dehydration of the clay or limonite bond, so that it will not rehydrate easily, and to destruction of the colloids by high temperatures.

Market and Prices

Although some firms produce sand for molding purposes a large part of it is of the same grade as glass sand and is sold as surplus from sand prepared for other uses. The prices[3] quoted for molding sand during 1929 ranged from

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[3] Metal and Mineral Markets (Eng. and Min. Jour. Press quotations), New York (weekly).

Original from THE OHIO STATE UNIVERSITY

$0.65 to $3.50 per ton, f.o.b. producing plant. During 1930 the minimum price declined to $0.50 per ton, while the maximum price remained at $3.50.

GLASS SAND

Sand for glass making, especially that for the better grades of glass, must have a high silica content. Most sand used for this purpose will contain more than 99 per cent silica. Both loose sand and that crushed and prepared from loosely cemented sandstone are used.

The quality of sand demanded by glass manufacturers depends largely on the kind and quality of glass being made. Glass may be classified according to chemical composition or the predominating basic oxide, or by physical characteristics that are largely controlled by the quality of the sand used. On this basis glass may be separated into optical glass, requiring sand of the highest purity; flint glass, for high-grade tableware that is to be polished and cut, requiring sand almost equal to that for optical glass; plate glass to be ground and polished, requiring a high-grade sand; window glass and plate glass which is not to be polished but used in the form of ribbed or wired glass, requiring a sand of less purity than above; green glass, which may contain much more iron oxide than that for the more colorless glasses; and different grades of amber glass, for which a sand with a fairly high content of iron oxide is permissible.

Table 2 shows the percentage composition of sands of various qualities (based on ignited samples). These specifications were formulated by the American Ceramic Society and the United States Bureau of Standards.

Table 2. - Percentage composition of sands of various qualities (based on ignited samples)

Qualities	SiO_2 minimum	Al_2O_3 maximum	Fe_2O_3 maximum	CaO+ MgO maximum
First-quality optical glass	99.8	9.1	0.02	0.1
Second-quality flint glass, tableware	98.5	.5	.035	.2
Third-quality flint glass	95.0	4.0	.035	.5
Fourth-quality sheet glass, rolled and polished	98.5	.5	.06	.5
Fifth-quality sheet glass, rolled and polished	95.0	4.0	.06	.5
Sixth-quality green glass, window glass	98.0	.5	.3	.5
Seventh-quality green glass	95.0	4.0	.3	.5
Eighth-quality amber glass	98.0	.5	1.0	.5
Ninth-quality amber glass	95.0	4.0	1.0	.5

Market and Prices

The selling price of glass sand depends largely upon the quality of the sand and competitive conditions. According to Metal and Mineral Markets, during 1929 the price for glass sand ranged from $0.75 to $5.00 per ton, f.o.b. producing plant, while during the latter part of 1930 it was quoted at $1.25 to $5.00 per ton.

FIRE OR FURNACE SAND

Fire or furnace sand is used to line furnace bottoms and walls, especially in furnaces that make acid open-hearth steel. It is also used largely in forming the bottoms of copper-refining furnaces and reverberatory copper smelting furnaces.

Although this sand, sometimes called "silica sand" by the trade, should have a high silica content, a small amount of bonding material is required to hold the sand in place until the furnace has been fired or burned in. If the sand lacks bond plastic fire clay may be added. Many sands used have enough natural bond and are often more desirable than artificially bonded material. Sand as low as 80 per cent silica has been used in extreme cases, but a silica content greater than 95 per cent is usually specified.

The chemical analysis is important, as it indicates the refractoriness of the sand. The alkali content should be very low, and as clay is the best bonding material it is the least objectionable impurity.

As to grain size, the sand should be uniformly graded from fine to coarse, and from 95 to 99 per cent should be retained on a 200-mesh screen.

In the more important producing centers soft sandstone of high silica content is used, as in the crushed form it contains enough bonding material to meet the specifications of the steel industry.

Because furnace sand is comparatively cheap attempts are always made to find sources of supply near consuming or steel-manufacturing centers. The principal producing States are therefore also the principal steel-producing States--Pennsylvania, Illinois, Ohio, Indiana, and New York.

The average value of the furnace sand produced in the United States during 1929 was $1.09 per short ton, f.o.b. producing plant, as compared with $1.07 per short ton for 1930[4]

ABRASIVE SAND

Blasting Sand

Sand-blasting sand has considerable application in industry. Although formerly used mainly for cleaning foundry castings it is now employed to remove paint from old surfaces, preliminary cutting for ornamental glass such as cut-glass tableware, cleaning and renovating walls of stone and brick buildings, preparing the surface of metals for the electrolytic bath and for enameling, and engraving, carving, and lettering on stone, marble, and glass.

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[4] Metal and Mineral Markets (Eng. and Min. Jour. Press quotations), New York (Weekly).

Original from THE OHIO STATE UNIVERSITY

Specifications for sand-blasting sand generally state that 100 per cent shall be retained on 100-mesh and 99 to 100 per cent on 65-mesh. All shoul pass a 14-mesh sieve.

Opinions differ as to the shape of the grains. Advocates of sharp grains claim they are faster cutting, and advocates of the rounded grains claim smoother work and longer life of the sand. The toughness of the quartz grains is a very important property and varies widely with different sands.

Blast sand was quoted at $1.35 to #3.50 per ton, f.o.b. producing plant, during 1929; during 1930 the range was $1.35 to $6.00 per ton.[5]

Sand for Wire-Saw Cutting.

One of the newer uses for quartz sand is as a cutting medium in slate quarrying by the wire-saw method. The sand should be of fairly uniform size and should contain little silt, clay, or fine sand particles. If there are pebbles in the sand they gradually fill the cut, making it difficult to supply sand. No definite specifications have been established for the sand, but a pure quartz sand running 99 per cent through 20-mesh and 95 per cent through 70-mesh is now widely used. Apparently, a coarse sand does not cut as rapidly as a moderately fine sand.

The price of the sand used in wire-saw cutting is estimated at about $4 per ton delivered at the slate quarry.

Other Abrasive Uses

Sand of different chemical purity and size of grain is used for first and second or semifinal grinding of plate glass, for beveling plate glass, and for sawing and grinding stone and marble.

Specifications for glass-grinding sand are not strict, and the cheapest available material that will do the work is generally used. Chemical purity has no importance except to indicate the presence of minerals that may be considered waste, because they are too soft to do much grinding.

Banding sand, which is used for the second or semifinal grinding and for beveling plate glass, is much finer than that used for first grinding. Artificial abrasives, however, have replaced this sand to a great extent.

For rough grinding of stone and marble the same grade of sand is generally used as for stone sawing. Sharp, angular grains are considered best, but as the cuttings are used over and over, any sand soon becomes round-grained and hence this preference is somewhat arbitrary. A sand with hard, tough grain that will not readily break down is best.

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[5] Metal and Mineral Markets (Eng. and Min. Jour. Press quotations), New York (weekly).

[6] Bowles, Oliver, The Wire Saw in Slate Quarrying: Tech. Paper 469, Bureau of Mines, 1930, pp. 14-15, 26.

FILTER SAND

Good filter sand must be fairly uniform and fall within certain limiting sizes. Moreover, it must be free from clay and organic matter and of high chemical purity, specifications generally stating that not more than 2 per cent shall be soluble in hot hydrochloric acid. Other specifications require that the combined lime and magnesia, calculated as carbonates, shall not exceed 2 per cent. Aside from this, the chemical composition is seldom specified.

With regard to grain size specifications usually state that no grains shall be larger than a certain mesh and limit the percentage that will pass a 100-mesh sieve, as during the washing of the filter bed with countercurrent flow the fines collect in the top part of the sand bed and clog the filter.

ENGINE SAND

Engine sand is used to prevent the driving wheels of locomotives, street cars, and other self-propelled vehicles from slipping on wet or slippery rails. The sand should contain a minimum of dust or very fine particles and be free from large grains, clay, vegetable matter, or any substance that would tend to absorb moisture and form lumps in the storage bin. The general specification is that the sand should be sharp (rounded grains tend to roll off the rails before being caught under the drivers), should all pass a No. 20 sieve, and be retained on a No. 80 sieve. The free-running property is quite important.

ROOFING MATERIALS

Sand and finely ground silica are used in coating prepared roofing. The sand for this purpose is white or colorless and is not the material applied to roofing built up in place. Although sand of sharp or angular grain is sometimes used a round-grained product is preferred. The specifications usually require that about 11 per cent pass an 80-mesh screen, about 90 per cent be retained on 80-mesh, and about 70 per cent be retained on 60-mesh. The sand should be well graded from coarse to fine, the fine predominating. It should be reasonably free from rubbish and other organic substances, as well as clay and iron.

Finely-ground silica is used in the manufacture of asbestos shingles. As high as 40 per cent silica is sometimes employed. There are no special requirements for this purpose other than that it must pass through a 200-mesh screen and that it shall be colorless.

At one time pulverized quartz was largely used for dusting roofing papers, to keep the rolled sheets of tar paper from sticking, but it has now been replaced largely by ground mica.

TRIPOLI

In the United States there are two distinct types of tripoli, that from the Missouri-Oklahoma field and that from the Illinois-Tennessee field.[7]

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[7] Ladoo, R. B. Nonmetallic Minerals, Occurrence, Preparation, and Utilization: New York, 1925, p. 642.

Rottenstone, which is produced in the United States only in Lycoming County, Pa., is a somewhat similar product.

The Missouri-Oklahoma type of tripoli occurs in layers in compact bedded deposits. It is an extremely porous, light-weight material ranging from loosely coherent to fairly compact and is easily crumbled between the fingers.

The Illinois-Tennessee type of tripoli ranges in structure from being pulverulent and entirely noncoherent in the Tennessee phase to hard, compact, and rather dense in the Illinois phase. It is often found in extensive, thick beds more or less mixed with unaltered chert. The Illinois phase is so hard and compact that much of it can not be crushed between the fingers, although it can be cut with difficulty with a knife. It is only slightly absorbent compared with the Missouri material.

Tripoli has many desirable properties for general filler use, the most important being color (as it can be obtained pure white), relative inertness to chemical action and moderate heat, and comparative ease with which it can be finely pulverized.

The Missouri type of tripoli has been found to be especially adapted to the manufacture of foundry facings of a certain type and to metal buffing and burnishing compounds. For the latter use the fact that tripoli grains break down easily under pressure has primary importance. About 60 per cent of the production of the Missouri district is marketed for the manufacture of foundry facings.[8]

Due to its absorbent properties tripoli is used to a considerable extent as a washing powder, acting as a mechanical cleanser with soap and other detergents. Tripoli is used in massive form only for the manufacture of stones for filtering small supplies of water, but with the almost universal adoption of municipal filtration plants its use for this purpose has practically ceased.[9]

The Illinois-Tennessee type of tripoli is employed interchangeably with pulverized silica for many uses, principally as a filler or inert extender in paints and transparent wood fillers. As an extender in paint the material must be pure white and finely ground. Illinois and Tennessee tripoli is suitabl for this purpose, but the Missouri material can not be used, as it is tinted with iron oxide. For use strictly as an inert extender tripoli surpasses pulver ized quartz, as it does not settle out of the paint mixture so readily.

Some tripoli is being used as a filler in hard-rubber compounds, espec ially that used for battery jars and containers. It is reported that it is used as a filler in the manufacture of phonograph records and as a carrier of insecticides for plant and tree dusting.

Tripoli from the Illinois and Tennessee fields is used to some extent as a source of silica in the manufacture of whiteware, with the idea that if it can be produced at a price comparable with that of pulverized quartz the demand probably will grow.

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[8] Butler, P. B., and Levings, G. V. B., Tripoli, Its Properties, Occurrences, History, Preparation, and Uses: Metal Ind., January, 1924, pp. 10-14.

[9] Weigel, W. M., Technology and Uses of Silica and Sand: Bull. 266, Bureau of Mines, 1927, p. 173.

Market and Prices

Tripoli is usually sold by reputation, trade name, and sample rather than by definite physical or chemical specifications, as are most other forms of silica.[10] The governing factors are the amount of free quartz grains or "grit," color, and fineness. Material from the different districts is to a great extent prepared to suit certain markets and requirements, so that their products are comparable only in a general way.

Of the total output of tripoli in the United States approximately one-third is sold for foundry parting, one-third for use in paint and wood filler, and the balance for various purposes, mostly abrasive.

The prices quoted in Metal and Mineral Markets[11] for 1929 and 1930 were as follows:

Tripoli, mill run, f.o.b. plant, Missouri, in burlap bags, paper liners, minimum carload lots 30 tons, for the first four months of the year, $15 per short ton; for the balance of the year, $16 per short ton. The 1930 price remained constant at $16 per ton.

Tripoli (rose and cream) air floated through 200-mesh, f.o.b. plant, Missouri, in burlap bags, paper liners, for the first four months on 1929, $25 per short ton; for the remainder of the year, $27.50 per short ton. In 1930 the price remained at $27.50 through September, then declined to $22.50 per ton for the rest of the year.

Tripoli (rose and cream) double ground through 110-mesh, f.o.b. plant Missouri, in burlap bags, paper liners, for the first four months of 1929, $17 per short ton; for the remainder of the year, $18 per short ton. During 1930 the price remained constant at $18 until December, when it fell to $17 per ton.

Tripoli (rose and cream) once ground through 40-mesh, f.o.b. plant Missouri, in burlap bags, paper liners, for the first four months of 1929, $14 per short ton; the remainder of the year, $16 per ton. In 1930 the price remained at $16 through November, when it fell to $15 per ton.

Producers

The companies producing tripoli (including Pennsylvania "rottenstone") in the United States in 1929, with the locations of the deposits from which the material was obtained, follow:[12]

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[10] Weigel, W. M., Work cited, p. 175.

[11] Metal and Mineral Markets (Eng. and Min. Jour. Press quotations), New York (weekly).

[12] Bowles, Oliver, Abrasive Materials: Mineral Resources of the United States, Bureau of Mines, 1929, Pt. II, pp. 65-81.

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Arkansas

Benton County: Rogers--Corona Silica (Inc.).

Illinois

Alexander County:
  Elco--
    Illinois Silica Co. (address, Cairo)
    International Silica Co. (address, Cairo)
  Olive Branch--Olive Branch Mineral Products Co. (address, Mound City)
  Tamms (near)--
    American Minerals Corporation (address, Murphysboro)
    Isco-Bautz Co. (address, Murphysboro)
    Star Silica Co. (address, Cairo)

Missouri

Newton County:
  Racine--Independent Gravel Co. (address, Frisco Building, Joplin)
  Seneca--American Tripoli Co.

Oklahoma

Ottawa County: Seneca, Mo. (near)--American Tripoli Co. (address, Seneca, Mo.)

Pennsylvania

Lycoming County: Antes Fort-Penn Keystone Co. (address, 551 Fifth Avenue, New York, N. Y. (Rottenstone)

Tennessee

Bradley County: Cleveland (near)--Southern Minerals Corporation (address 192 Bank Street, Burlington, Vt.)
Wayne County: Waynesboro--C. C. Houston & J. W. Young (address, Lewisburg)

DIATOMITE

Diatomite is a form of opaline silica consisting of the siliceous remains of diatoms. It is a loose, pulverulent material with a mealy or earthy texture and resembles soft chalk or dried clay. It is very light, having a specific gravity of 0.24 when dry and 0.34 when calcined.

The value of diatomite for most uses depends upon its physical structure. The hollow cells of the diatoms form dead air spaces, the cause of the low apparent density of diatomite and the reason for its value as an insulating medium--the principal use, at present, for this material. It is a bad conductor of heat, electricity, and sound and is resistant to heat and most chemicals.

The great number and exceedingly small size of the cells cause diatomite to be of great value as a filtering medium. The presence of these minute cells also causes the material to be exceedingly adaptable as an absorbent. Good material absorbs four to five times its weight of water.

Diatomite is classed as a mild abrasive. The original particles are not only rather fine but owing to their fragile structure break down easily under pressure. Because of this the material is well adapted for final finishing in such products as metal polishes, automobile cleaning and polishing compounds, buffing compounds, finger-nail polish, tooth paste; and various other products where a mild but hard abrasive is needed.

Considerable quantities of diatomite are being used as an aggregate or addition to concrete. Its purpose is twofold: (1) As an addition to absorb excess water which is slowly released as the concrote sets and (2) as a lubricant. The use of diatomite as a lubricant finds considerable use at central mixing plants, as it allows less water to be used and keeps the concrete in a soft, easy flowing condition until it is delivered on the job. The use of diatomite for this purpose is growing rapidly, especially in districts adjacent to diatomite deposits.

The advantage of diatomite as a source of free silica for chemical purposes is that it is more soluble than quartz. It is used to some extent in the manufacture of sodium silicate. Employment as a filter and absorbent is also closely allied to use in the chemical industry.

The special properties and characteristics of diatomite open up numerous possible fields for its utilization; it has already found application in some of them. These include utilization as a packing material around glass containers when the contained reagents might cause spontaneous combustion in contact with organic material, in various cements, fireworks, blackboard crayons, fertilizer carriers, porous chemical ware, glazes, dusting powders, and foundry partings. It is also suggested for use as a filler or packing for gas-absorption towers. Material of the proper physical strength and porosity may be used as a medium through which air is blown into a solution, and the fine size of the resulting bubbles causes intense aeration or oxidation. At least 12,000 and possibly 20,000 tons of diatomite are used annually as a filler in battery boxes, chiefly for automobile storage batteries.

Market and Prices

Diatomite is marketed as a pulverized product reduced to different degrees of fineness--crushed aggregate, crude lumps, sawed bricks, and blocks from the solid (green or calcined), and bricks formed from powdered material and kiln burned.

It should be remembered that diatomite is an exceedingly light, bulky material, hence freight rates will be correspondingly high, and only the best grades will stand a long freight shipment.

Pulverized material and aggregates are packed in bags holding 90 to 100 pounds, and the cost of the container is an important item in the selling price. Crude air-dried lumps are usually shipped in bulk. Bricks and specially shapes such as filter blocks sawed from the solid are fragile and are packed in paper cartons or crates to weigh 50 to 75 pounds.

According to Metal and Mineral Markets[13] the price for diatomite, natural aggregate, 1/4-inch size, f.o.b. producing plant remained at $18 to $20 per short ton for the years 1929 and 1930.

Diatomite, kiln-fired aggregate, 1/4-inch size, was quoted at $45 per short ton f.o.b. producing plant for 1929 and 1930.

Diatomite, kiln-fired brick, was constant at $65 per short ton in 1929 and 1930, f.o.b. producing plant.

Diatomite, 80 to 85 per cent silica, 98 per cent through 200-mesh, was quoted at $20 per ton, carload lots, f.o.b. producing plant, for the first half of 1930; no prices quoted for 1929.

Diatomite, insulating powder, f.o.b. producing plant, was quoted at $25 per short ton during 1929 and 1930.

Diatomite, air-floated powder, stood at $45 per short ton, f.o.b. producing plant, for the first seven months of 1930. No quotations are available for 1929.

Producers

The companies producing diatomite in the United States in 1929, with the locations of the deposits from which the diatomite was obtained were as follows:[14]

California

Fresno County: Mendota--Mineral Products Manufacturing Co. (address, 1735 Ventura Avenue, Fresno)
Los Angeles County: Torrance--Floatstone Products Co. (address, 423 Wall Street, Los Angeles)
Monterey County: Monterey (near)--The Calatom Co. (Ind.) (address, Monterey)
Santa Barbara County:
    Lompoc--
        Celite Corporation
        National Silica Products Co. (address, 605 Market Street, San Francisco)

Florida

Lake County: Clermont--Florida Diatomite Co.

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[13] Metal and Mineral Markets (Eng. and Min. Jour. Press quotations), New York (weekly).

[14] Bowles, Oliver, Abrasive Materials: Mineral Resources of the United States, 1929, Bureau of Mines, Pt. II, pp. 65-81.

Maryland

Calver County: Dunkirk (near)--Diatomaceous Products Co. (Inc.) (address, 907 Fifteenth Street, N.W., Washington, D. C.)

Nevada

Elco County:
  Carlin--
    Carlin Products Co. (Inc.) (address, 676 Subway Terminal Building, Los Angeles, Calif.)
    Tri-o-lite Products Co.
Esmeralda County: Basalt (near)--U. S. Diatom Co. (address, 800 Santa Fe Avenue, Los Angeles, Calif.).
Storey County: Virginia City--The Electro-Silicon Co. (address, 22 Cliff Street, New York, N. Y.).

New Hampshire

Grafton County: Canaan--New England Minerals (Inc.) (address, 85 Devonshire Street, Boston, Mass.)

New York

Herkimer County: Poland--Adirondack Diatomaceous Earth Co. (address, Herkimer)

Oregon

Deschutes County: Terrebonne--Atomite Corporation (address, 1921 Pacific Building, Portland)
Malheur County: Harper--Whiteurth Products Corporation

Virginia

Westmoreland County: Oak Grove--American Diatom Co. of Virginia (address, 618 Witherspoon Building, Philadelphia, Pa.)

Washington

Kittitas County:
  Kittitas--Kittitas Diatomite Co. (address, Ellensburg)
  Roza--Washington Silica & Fire Clay Co. (address, 3205 Hewitt Avenue, Everett)